APPENDIX B

REHABILITATION EVALUATION REPORT

B-1. Study Procedures and Reports. Major Rehabilitation Evaluation Reports will include engineering, environmental, and economic studies. Studies should be undertaken and the reports prepared in coordination with the Planning, Engineering, Operations and Project Management elements. Early coordination should occur with the potential cost sharing partners and other affected agencies. Engineering reliability studies should be prepared in consultation with CECW-E. However, a coordinated team effort among all functional elements will be utilized throughout the entire study process.

a. Report Name. The evaluation report will be called by the project's authorized name followed by the words Major Rehabilitation Evaluation Report.

b. Funding. The Rehabilitation Evaluation and report preparation will be funded under the Operation and Maintenance, General, appropriation.

c. Illustrations. The use of color photographs in the reports to illustrate features for proposed rehabilitation and to highlight specific problems is highly recommended. Photographs should be accompanied by narrative description that explain what is being depicted.

B-2. Study Objectives. The rehabilitation study requires rigorous analysis and reporting. The level of detail should be commensurate with the proposed action. The objectives of the study are as follows:

a. Establish the overall engineering condition and reliability of the project and all major project features at the current time. Analyses should identify reliability problems associated with critical project features as well as identify those project features which are not unreliable. This analysis should be conducted given the current and anticipated future "without project" condition of the features to establish a base condition. The results of the reliability analysis will be considered in conjunction with the economic and environmental studies to establish priorities for funding and to establish the objectives of the rehabilitation project.

b. Identify and define the operational and/or potential reliability problems and/or opportunities for efficiency improvement.

c. Identify alternative methods to resolve or manage the problem.

d. Develop cost estimates for the proposed solutions.

e. Determine if the proposed project is eligible for funding under the major rehabilitation program and if so under which categories.

f. Estimate the total economic cost and benefits of the base condition and alternative solutions.

g. Identify cost sharing requirements, if applicable.

h. Identify all environmental concerns and complete all environmental reporting requirements.

i. Identify the recommended plan. The recommended plan will identify the optimum investment, both in terms of proposed actions and timing of proposed actions, given the risk and uncertainty identified during the study. There may be circumstances where the risk and uncertainty is such that more than one plan of action may be considered to reasonably maximize net benefits. There may also be circumstances where priorities for Federal investments and alternative financing may be an appropriate mechanism to obtain full NED level of development. These should also be identified and fully described in the report.

j. For the recommended plan of action, develop a M-CACES cost estimate.

k. Prepare a proposed draft Project Cooperation Agreement (PCA) with a non-Federal cost-sharing partner if required.

1. Prepare a Project Management Plan (PMP) for the recommended alternative. The project manager, in coordination with Planning, Engineering, Operations and other functional elements will develop a PMP in accordance with ER 5-7-1 (FR). The plan will identify the timing of proposed investment, outlays and physical completion through the implementation period.

B-3. Format and Content of Rehabilitation Evaluation Reports.

a. Project Authorization. Provide pertinent information on the project authorization, including any modifications.

b. Location and Description. Describe the project location and provide a vicinity map, plan and elevation of the structure as an enclosure. Provide a narrative description of the current operation and use of the project, the associated project benefits and the recipient of project benefits.

c. Identification of Problems and Opportunities. Describe the physical characteristics of all significant project features. Special attention should be given to features which have experienced unsatisfactory performance and which receive special emphasis in the report. In the case of efficiency improvement, describe the opportunity for efficiency improvement (Reference ER 1105-2-100, Section 5-4, Summary of the Planning Process\.

d. Project History.

(1) Current and Historical Conditions, Maintenance, Repairs and Modification.

(a) Describe the physical condition of the project and project features including an assessment of the engineering condition and reliability of each. Table 3-1 provides an example for summarizing this information. The current condition review should include a narrative description of the condition and reliability of each feature. The purposes of the narrative and Table 1 are to support special attention to the feature or features proposed for major rehabilitation by this report. Of particular importance is the role of the feature in the performance of the project and the feature’s function in the operation of the project. Diagrams, drawings and photographs in sufficient detail to portray the project and proposed rehabilitation features in their

current condition, should be included in this description. High quality color photographs are especially important to enable the reviewer to visualize and appreciate the features and their condition. The reviewers are normally unfamiliar with the project and are relying solely on the content of the report to make investment decisions.

(b) Provide a history of project cost. Describe and display on an annual basis the operation, maintenance, repair and rehabilitation cost history of the project. The maintenance, repair and rehabilitation costs for the feature(s) proposed for rehabilitation should be shown separately. Include a description of the important repair and maintenance activities on the project.

(c) Describe and display instances of service disruption and emergency repairs. This should include all significant episodes of service disruption. Describe the consequences to the system (i.e., describe the socioeconomic effects of the disruption in service). The description of each event should contain all the conditions that are relevant to the disruption of service, not only those that are related to the feature's physical condition. These might include ice build-up, impact damage from barges or debris, or rare natural events. The description and display should include length of time the project and/or project feature was out of service and the costs associated with each event. These costs are the emergency repairs and increased O&M after the event, but attributable to the event, and project benefits which would be lost if this disruption of service occurred under current conditions. State all figures in current dollars. The repair may also change (reduce or increase) the frequency of future service disruptions and may reduce future O&M costs. These possibilities should be considered and included in the analysis, if warranted.

(d) Describe and document quantitatively historical changes in the service level capable of being provided by the project. This should provide documentation on any chronic decline in the capability of the project to produce beneficial outputs due to deterioration or other factors related to a feature's physical condition. This information should be provided for at least the last 10 years. Special attention should be paid to the contribution of the feature(s) proposed for rehabilitation, and to the degradation in service level.

e. Economic Considerations.

(1) Federal Interest. For the majority of cases, the Federal interest in an existing project will be obvious. However, reasonable argument which shows a Federal interest, and in some cases, a non-Federal interest (i.e., proposed cost sharing), will be provided in the report. Emphasis shall be placed on project outputs and whether they serve priority purposes as defined in the Annual Program and Budget request for Civil Works Activities, Corps of Engineers.

(2) Base Condition. The base condition is the alternative which all other plans will be measured against. In comparison to other Corps planning studies, the base condition is synonymous with the "without project" condition. The base condition assumes that the project will be operated in the most efficient manner possible without the proposed rehabilitation. Should the project benefit stream be interrupted due to unsatisfactory feature performance, it is assumed that emergency funds will be available to fix the feature. For the economic analysis, allowance must be made for the effect of the repair on the reliability of the feature. Considerable risk and uncertainty is inherent in the base condition. The timing, frequency, and consequences of system disruption are all unknown and must be estimated. The analysis should explicitly

show the effects of reasonable alternative assumptions concerning these variables. Portray the base condition in the following manner.

Table B-1
BASE CONDITION - SUMMARY[1]

No.	Description[2]	RELIABILITY					UNSATISFACTORY PERF.			ASSESSMENT				
		Summary Assessment	Basis for Assessment	Current	Cause	Future	Mode	Immediate	Consequence	Probable	Estimated	Cost	Benefits	Environment
	tru													
	W													
	M													
	Ga													
0253	Spillway Channels													
0299	Associated General Items													

[1] See Enclosure 5 for examples of potential entries, descriptive footnotes, and potential supporting narrative description.
[2] Description of Item - Although there is no specific list, the M-CASES work breakdown structure could be used to assist in organizing he data.

Step 1. Based upon the reliability index (see paragraph f, Engineering Considerations) calculated for the current physical condition, select the probability of unsatisfactory performance for each feature, or component, from Table D-1 of Appendix D. If the probability of unsatisfactory performance is due to a combination of events, provide the method used to determine these probabilities. Both the probability of unsatisfactory performance of a feature and the probability of occurrence of an event which results in load conditions causing the unsatisfactory performance shall be explicitly discussed and displayed. Reporting requirements to support the reliability analysis are addressed in Appendix D.

Step 2. Based on the existing physical condition of, and the current and forecasted demands on the features, estimate the frequency of service disruption and the physical consequences resulting over the planning period. Frequencies and consequences should be expressed in terms which are unambiguous and which facilitate analysis. For example, estimate the percent chance of disruption per year (annual probability) or probability of disruption per event (per event probability).

Step 3. Develop an event tree. A useful way of presenting information of alternative future pathways is an event tree diagram. The event tree is used to display the possible outcomes from some initiating event. Figure C-1 is an event tree for a hydroelectric generating facility.

Step 4. Estimate all costs necessary to correct the service disruption. The repair should be the least cost fix necessary (as considered reasonable for the circumstances) to continue service.

Step 5. Estimate the economic cost for each disruption. (See Appendix E)

Step 6. Combine the frequency of service disruption with the consequences of disruption. Monte Carlo simulation is one technique for combining risks and determining expected values. This technique is especially useful when the arithmetic of the expected value calculation is highly complex or intractable. Under some, perhaps many situations, the standard statistical procedure of summing the products of the probabilities and corresponding consequences is sufficient. That is, calculating the value analytically may be more expedient and transparent than estimating by simulation. An advantage of the Monte Carlo approach is that it yields both the expected value and the variance. The fundamental point of the analysis however, is to explicitly consider the likelihoods and consequences of the base condition. See Appendix F for further consideration of this approach.

(3) With Rehabilitation Condition.

(a) General. As previously stated, the base condition should@ describe an immediate or certain failure. Nor is the only project alternative immediate and full scheduled rehabilitation. There are a variety of intermediate strategies that should be evaluated. In addition, the rehabilitation decision must give consideration to the choice of timing and extent of rehabilitation. Therefore, the approach is to develop alternatives to solve the problems. This does not predetermine that one major rehabilitation scenario is the only alternative.

(b) Alternatives Considered. Discuss the alternatives considered. The narrative should address the level of detail developed for each alternative, the data available, assumptions made and the level of reliability y, risk and uncertainty associated with the alternative. Present the

results of the analysis for each alternative. The following represent some potential alternative plans that should be evaluated and compared.

- Advance maintenance strategy. Advance maintenance consists of expenditures in excess of routine O&M that reduces the likelihood of some emergency repairs and temporary service losses, or the rate of service degradation. Under this scenario, one must evaluate the effect that probabilities and consequences of the strategy have on expected service disruptions and reliability.

- Scheduled repair strategy. Assess the components of the feature in terms of the service disruption probabilities and consequences to the reliability of the structure. Based on this assessment, stockpile replacement parts and make other preparations on this assessment to reduce the time of expected project service disruption.

- Scheduled rehabilitation strategy. The scheduled rehabilitation strategy requires that the “optimum” rehabilitation timing be identified based on service disruption rates, service degradation and their economic cost.

- Immediate rehabilitation strategy.

(4) Summary Statistics. Provide a table to illustrate the cost, benefits, net benefits and benefit to cost ratios of the base condition and each alternative considered.

f. Engineering Considerations.

(1) Reliability Analysis

(a) General. Present a summary of the reliability analysis for the base condition and each alternative. The reliability of the various alternatives must be investigated in order to evaluate the relative merit of each alternative with respect to the base condition. In addition, if the base condition assumes that emergency repairs will be made to unreliable components or features, a post emergency repair reliability analysis must be made of the component or feature. Enclosure 2 provides an introduction to the principles and procedures to follow in conducting a reliability analysis, and the reporting requirements. Additional considerations are provided below.

(b) Probability of Unsatisfactory Performance. The reliability of a component or structure shall be stated in terms of the probability y of unsatisfactory performance of the feature. Unsatisfactory performance of a component maybe indicated at various levels of performance, depending upon the consequences of that performance level, from minor deflections to complete collapse of a structure. Probabilities of unsatisfactory performance should be calculated for a range of performance levels, however, failure scenarios which indicate threats to public safety should not be assigned probabilities using the procedures outlined herein. While these situations may be identified using reliability analysis techniques, they should be considered to be emergency situations and remediated outside to the major rehabilitation program. Probabilities of unsatisfactory performance must be calculated using the analytical procedures outlined in Appendix D, using one of four methods;(1) Reliability Indices; (2) Hazard Functions; (3) Historical Frequency of Occurrence Analyses and (4) Expert Elicitation. Expert Elicitation should only be used to establish subjective probabilities of unsatisfactory performance for preliminary screening purposes to determine the components or features which need further study, or when there is insufficient data to develop the probabilities from historical frequencies

of occurrence or analytical procedures. Expert Elicitation should only be used in consultation with CECW-E.

(c) Calibration of Reliability Models. Performance function models used to evaluate the project component or feature reliability should be calibrated by applying the model to at least two similar components whose performance is known. Reliability should be calculated for a similar component known to have suffered distress, and for another similar component known to meet current design criteria. If the performance function model does not accurately predict the known structural performance levels, the assumptions, conditions, simplifications and parameters used in the model should be reexamined and adjusted to realistically provide an accurate prediction.

(d) Time Dependent Reliability. The reliability of a component or feature varies with time due to many factors including environmental conditions, component stress history, corrosive resistance of the materials, as well as maintenance history. Therefore, a time-dependent reliability analysis must be conducted in order to consider the impact of these factors on project performance and service life. Projections of future changes in reliability should be based upon the calculation of performance functions using the procedures outlined in Appendix D. Rates of degradation in random variable properties should be based upon available existing data, industry practice and experience at similar projects. If available project data is scarce or non-existent, then estimating rates of degradation will require that considerable engineering judgement be exercised in consultation with CECW-ED.

(e) Engineering Characterization of Structural Features. The complex nature, time and cost of reliability analyses require that the number of elements analyzed for any project or feature be reduced to the critical elements, or to representative groups or sections. In some cases this can be done by grouping together elements or components which are similar and can be represented by a single element, or a small portion of a large element, i.e., the reliability of an entire length of lock wall might be represented by a typical one foot section of the wall. In other cases, it may be possible to group related elements together and represent the group by a single critical element. The reliability of the critical element (and its associated probability of unsatisfactory performance) would then be assumed to govern the reliability of the entire group of elements and they would then be considered as one element or component in the economic risk analysis. An example of this is in a steel miter gate or a steel truss which is dependent on the satisfactory performance of all members to resist loads. The unsatisfactory performance of one or more critical members would lead to the unsatisfactory performance of the entire structure.

(2) Engineering Consequences. The engineering, or physical, consequences of the expected level of performance should be described in detail for each performance function evaluated. The sequence of events caused by the unsatisfactory performance of a component should be reasonable, with consideration given to the importance of the component to the overall performance of the structure or feature. While “worst case” unsatisfactory performance scenarios need to be evaluated and described, lesser events should also be included since these higher probability events may have greater impact upon the service life of the structure and the economics of the project. If the unsatisfactory performance of components or features is expected to result in emergency repairs, provide an assessment of the impact of the repairs upon both the reliability of the repaired elements and those elements not included in the repairs.

(3) Engineering Evaluation of Alternatives. Alternative schemes for repair and rehabilitation must be fully investigated. Alternatives investigated should include the use of new

materials, new repair techniques and innovative designs as well as all reasonable alternative configurations. The schemes investigated must address and resolve concerns which have led up to the major rehabilitation proposal, such as declining reliability and consequences of unsatisfactory performance of the structure or component. Since complete reliability analyses must be conducted on all alternative schemes, only reasonable and technically feasible alternatives should be investigated. This requires a screening process to eliminate less reasonable schemes from consideration. Factors considered in the screening process should include, but not be limited to, technical feasibility, constructibility, and impacts upon appurtenant structures. Alternative schemes eliminated during this process for engineering reasons should be briefly described, along with the factors which resulted in elimination.

(4) Guidance.

(a) Basic reliability principles and an example for a steel miter gate are presented in ETL 1110-2-532, "Reliability Assessment of Navigation Structures", 1 May 1992. Additional guidance is also presented in ETL 1110-2-321 "Reliability Assessment of Navigation Structures, Stability of Existing Gravity Structures", 31 December 1993, and ETL 1110-2-354, "Reliability Assessment of Pile-Founded Navigation Structures", 31 August 1995.

(b) Hydropower. The reliability of turbines and generators, and other electrical/mechanical equipment may be determined by using "survivor curves. " Estimates of the initial reliability and the annual rate of change in reliability should be made for both the base condition and all rehabilitation alternatives. ETL 1110-2-337, Reliability Analysis of Hydropower Equipment, should be used and the Hydroelectric Design Center (HDC) should be contacted for guidance in the use of survivor curves and other reliability tools. (See Appendixes F and H for further discussion.) The reliability of appurtenant structures such as powerhouses, penstocks, gates, dams, etc. should be determined in accordance with Appendix D.

g. Environmental Considerations.

(1) Environmental Effects. Provide a brief description of the existing affected environment. Highlight significant resources that are likely to be affected as well as any that are covered by a specific law (e.g., endangered species, clean air, clean water, cultural and historical, etc). Identify potential hazardous and toxic wastes concerns, conduct studies and prepare appropriate reports in accordance with ER 1165-2-132. Identify the location and significance of impacts and justify any mitigation requirements including the mitigation cost estimate. Indicate the concurrence or nonconcurrence given by resource agencies on impact assessments and proposed mitigation plans. Identify any environmental constraints (project stoppers) that would render an alternative infeasible. Present a matrix of the alternative environmental considerations.

(2) Coordination and Correspondence. Provide a table indicating who was contacted, their affiliation, and a synopsis of their general concerns. Copies of all pertinent correspondence should be included in Appendix C of the report.

(3) Reports and Studies. This section summarizes the studies conducted to evaluate the environmental effects of the rehabilitation plan (e.g., biological, cultural, social, HTRW, studies, etc.).

(4) The reporting officer will be responsible for determining NEPA documentation (e.g., Environmental Assessment, Finding of No Significant Impact, Environmental Impact Statement)

based upon Corps regulations and 40 CFR Parts 1500-1508. All NEPA documents should be submitted with the Major Rehabilitation Report.

(5) Preparers. List who prepared which parts of the document report and their role.

h. Assessment of Alternatives.

(1) Critical Assumptions and Key Variables. For the Base Condition and each alternative considered, there are critical assumptions and key variables that are influential in estimating rehabilitation benefits and costs. In most instances these fall into the following categories:

(a) the initial risk (base condition and other alternatives),
(b) the annual rate of change in risk (base condition and other alternatives),
(c) the risk after repair,
(d) the cost of repair,
(e) the opportunity costs during repair and rehabilitation,
(f) the change in annual O&M cost with rehabilitation or other strategies, and
(g) the cost of each alternative.

The assessment should identify which of these variables is critical to reported economic evaluation of each rehabilitation alternative. The assessment should display the reasonable range for each of the critical variables identified and the sensitivity of the benefit-cost ratio and net benefits over these possible values.

(2) Reporting of Statistical Results. The output from the analysis of reliability based costs and benefits are statistics generated by analytical procedures or simulations involving probabilities. The resulting estimated benefits (and costs), therefore, are statistics in the form of means, variances, skews, etc. The reporting of the results of all alternatives should include a tabular display of the mean net benefits and standard errors. In addition, the display should provide a 90% confidence interval for the mean net benefits (mean+ 1.64x standard error) assuming that net benefits are normally distributed. Appendix F provides displays for a simplified example that can assist in developing the display of results for decision purposes.

i. Recommended Plan. Provide a recommendation supported by the engineering, economic and environmental analysis. Present the benefit to cost ratio and net benefits using the current Federal discount rate.

j. Major Rehabilitation Classification. Describe how the proposed project meets the requirements for Major Rehabilitation funding and the Reliability and Efficiency Improvement classification(s). Display benefits attributable to each classification and how costs are allocated to each classification.

k. Project Cost Estimate. Show a schedule of fully funded project costs and a breakdown of the Federal and non-Federal cost share, if applicable.

1. Cost Sharing Considerations. For navigation projects, major rehabilitation will be cost shared by the Inland Waterway Trust fund or the Harbor Maintenance Trust Fund in accordance with the WRDA 1986 as amended. Other cost sharing will be in accordance with any local (project) cooperation agreements related to the original project authorization. For hydropower rehabilitation, costs are reimbursed, over time, by the affected Power Marketing Agency (PMA). Some rehabilitation projects, in particular hydropower, may include both reliability and efficiency improvements. In this case, care must taken to clearly quantify the benefits and costs associated with each type of improvement. If efficiency improvement benefits are not incidental to a reliability based rehabilitation, special cost sharing maybe required. HQUSACE should be consulted early in the study process to clarify any cost sharing questions. See Appendix H for specific hydropower guidance.

m. As Appendix A to the report, present the results of the reliability analysis.

n. As Appendix B to the report, present detailed economic analysis.

o. As Appendix C to the report, present complete environmental documentation.

p. As Appendix D to the report, provide a M-CACES cost estimate of recommended plan.

q. As Appendix E to the report, provide a Project Cooperation Agreement with non-Federal cost-sharing partner, if applicable in accordance with paragraph 12 and tailored to the model shown in Appendix A of ER 1165-2-131.

r. As Appendix F to the report, provide a Project Management Plan. (Note: When the recommended plan has been identified and a M-CACES cost estimate prepared, a Project Management Plan must then be developed and submitted with the major rehabilitation report. Reports submitted without a Project Management Plan will not be considered for finding).

s. As Appendix G to the report, provide a schedule of fully funded project costs by fiscal year and a breakdown of the Federal and non-Federal cost share, if applicable.